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Ohtsuka

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(54) **SOUND RECORDING DEVICE**

(71) Applicant: **Panasonic Corporation**, Osaka (JP)

(72) Inventor: **Yoshio Ohtsuka**, Osaka (JP)

(73) Assignee: **Panasonic Intellectual Property Management Co., Ltd.**, Osaka (JP)

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H01R 107/00 (2006.01)

(52) **U.S. Cl.**
CPC ***H04R 3/005*** (2013.01); ***H04R 3/00*** (2013.01); *H01R 2107/00* (2013.01); *H04R 2410/00* (2013.01); *H04R 2499/11* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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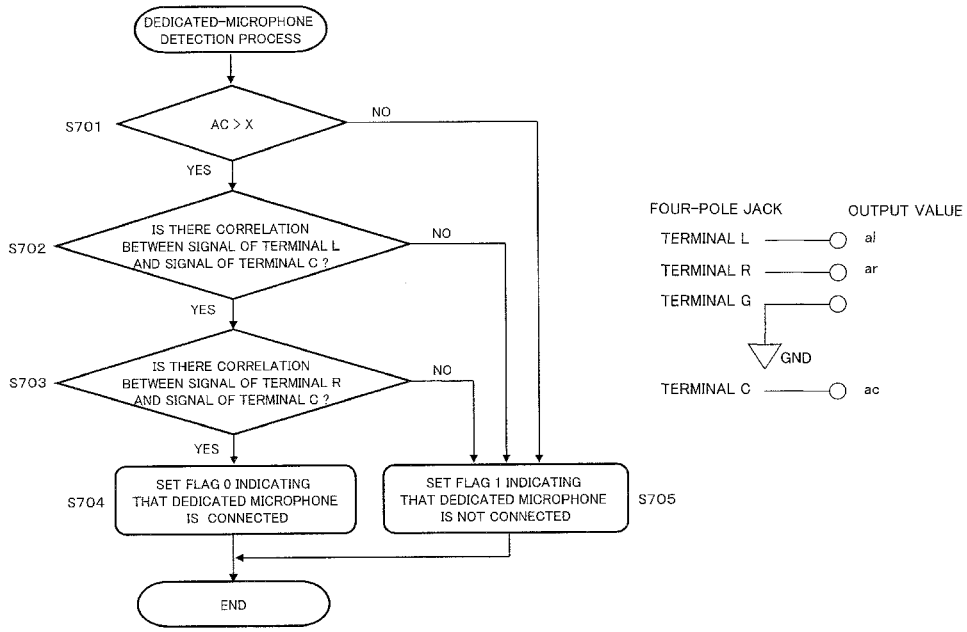
Primary Examiner — Wayne Young
Assistant Examiner — Mark Fischer
(74) *Attorney, Agent, or Firm* — Panasonic Patent Center

(57) **ABSTRACT**

A sound recording device of the present disclosure is can be connected with an external sound pickup device. The sound recording device includes a connector having a plurality of terminals to which the external sound pickup device can be connected, and a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals out of the plurality of terminals.

8 Claims, 8 Drawing Sheets



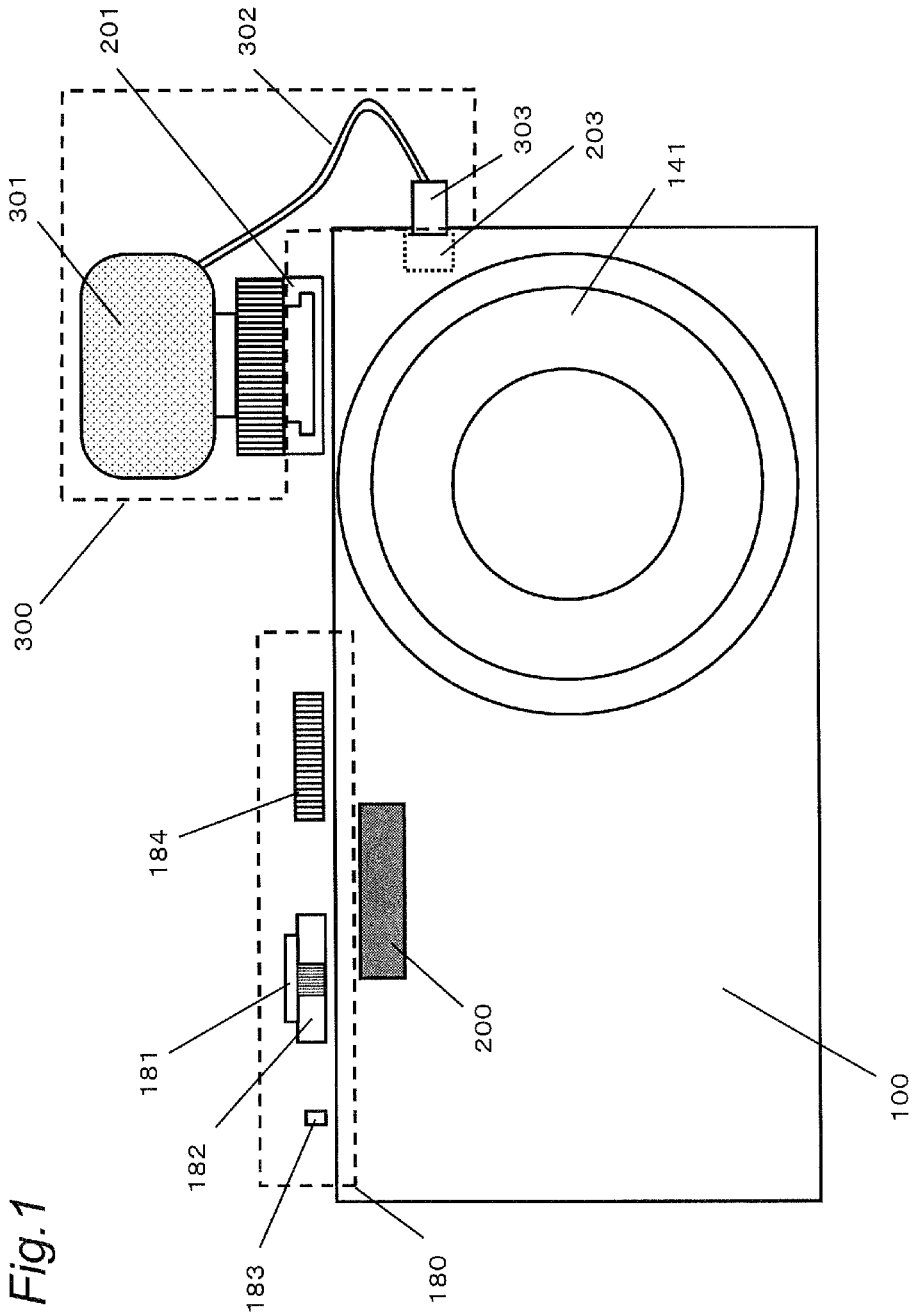


Fig. 1

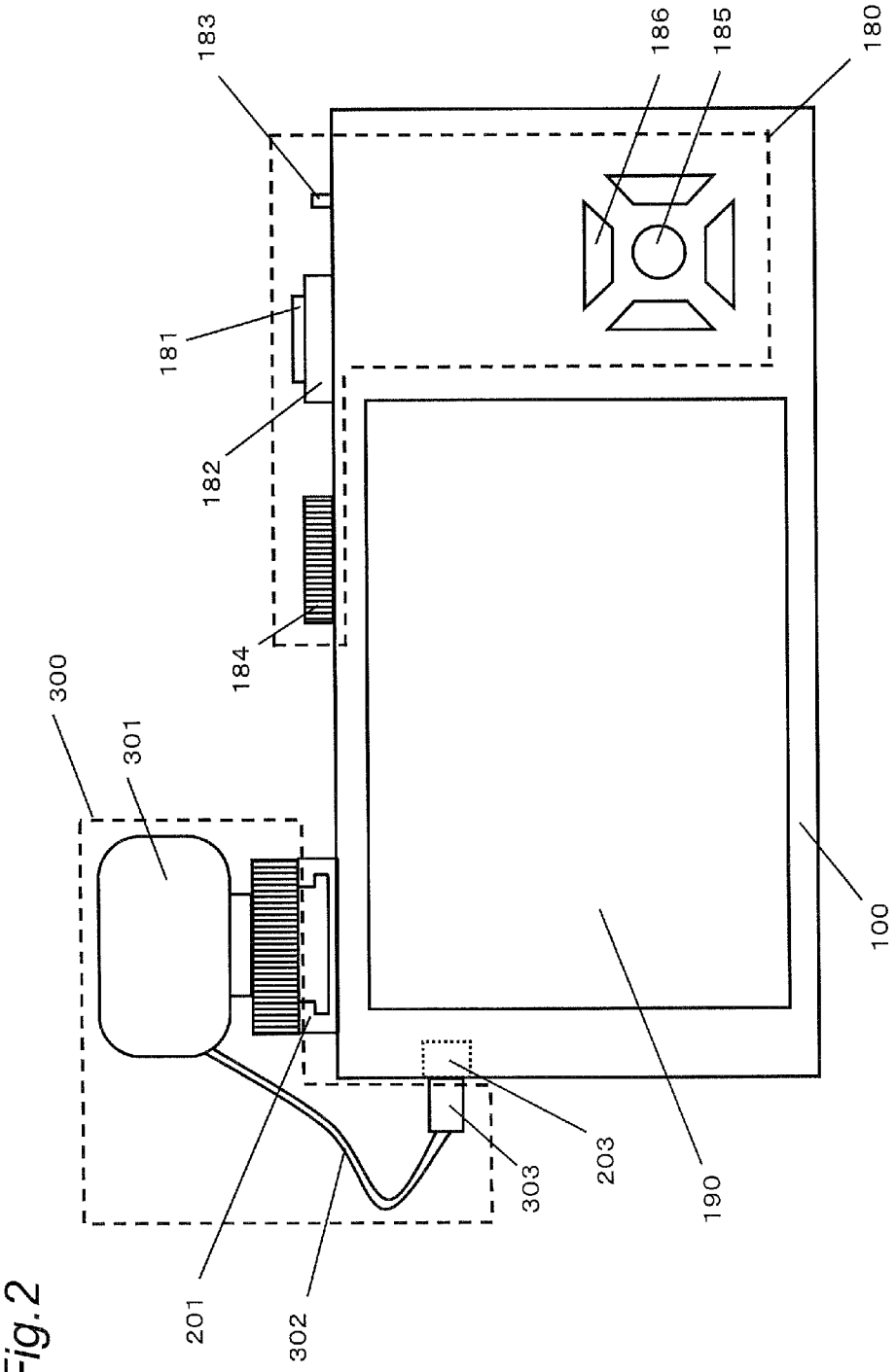


Fig.2

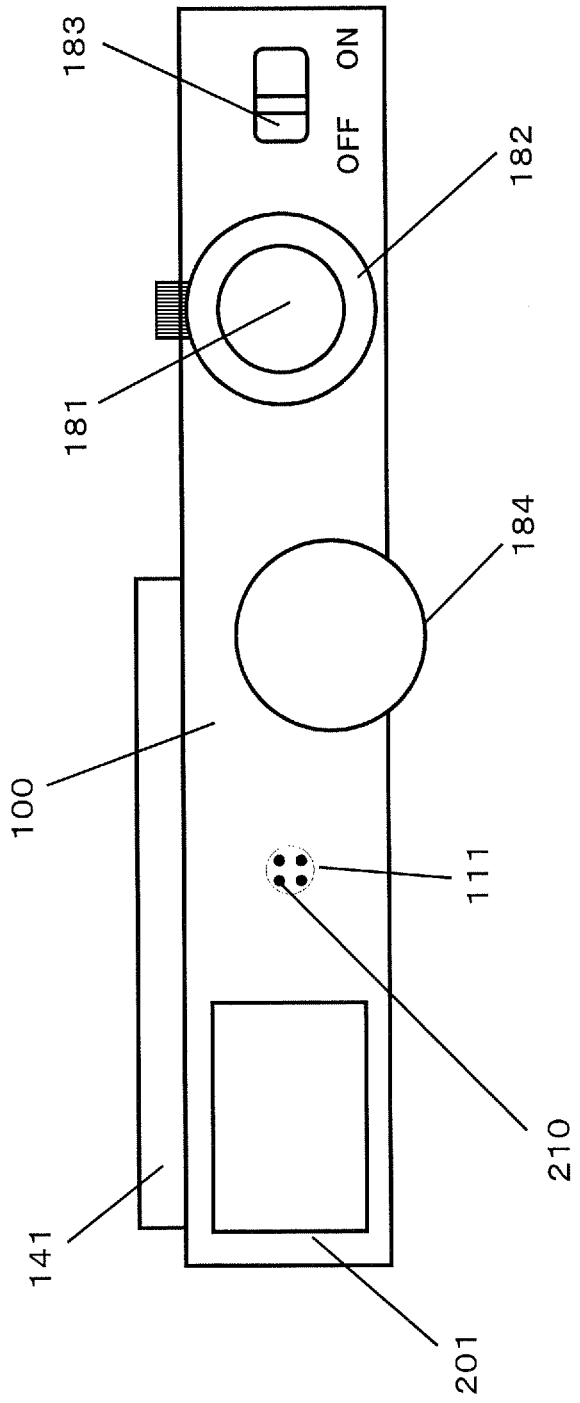


Fig.3

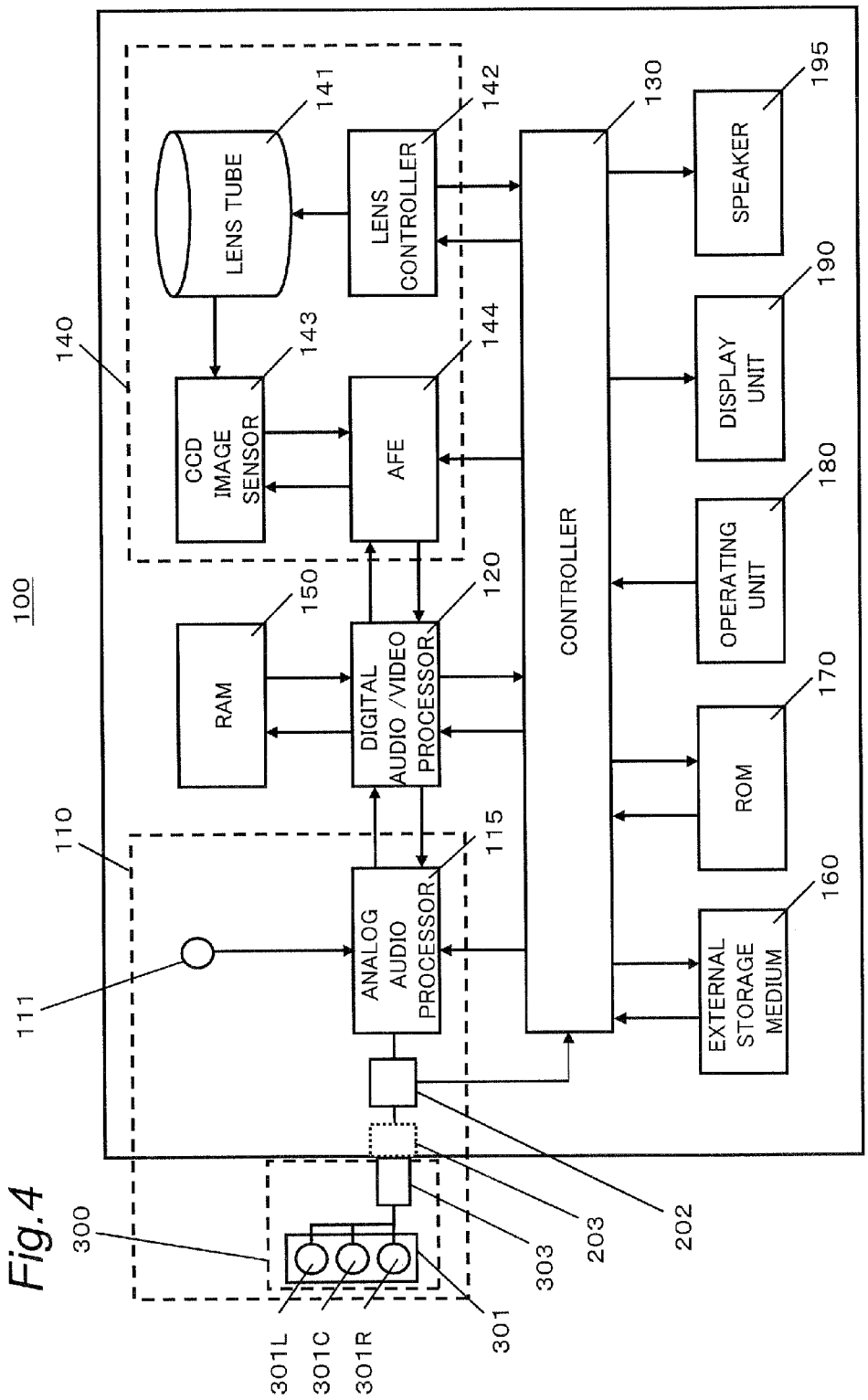

100
140
141
LENS TUBE
142
LENS CONTROLLER
143
CCD IMAGE SENSOR
144
AFE
150
RAM
120
DIGITAL AUDIO /VIDEO PROCESSOR
110
115
ANALOG AUDIO PROCESSOR
111
CONTROLLER
130
SPEAKER
195
DISPLAY UNIT
190
OPERATING UNIT
180
ROM
170
EXTERNAL STORAGE MEDIUM
160
202
203
303
301
300
301L
301C
301R

Fig. 4

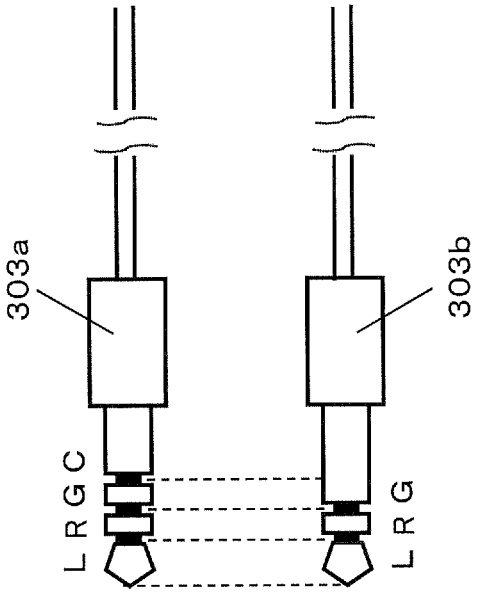


Fig.5

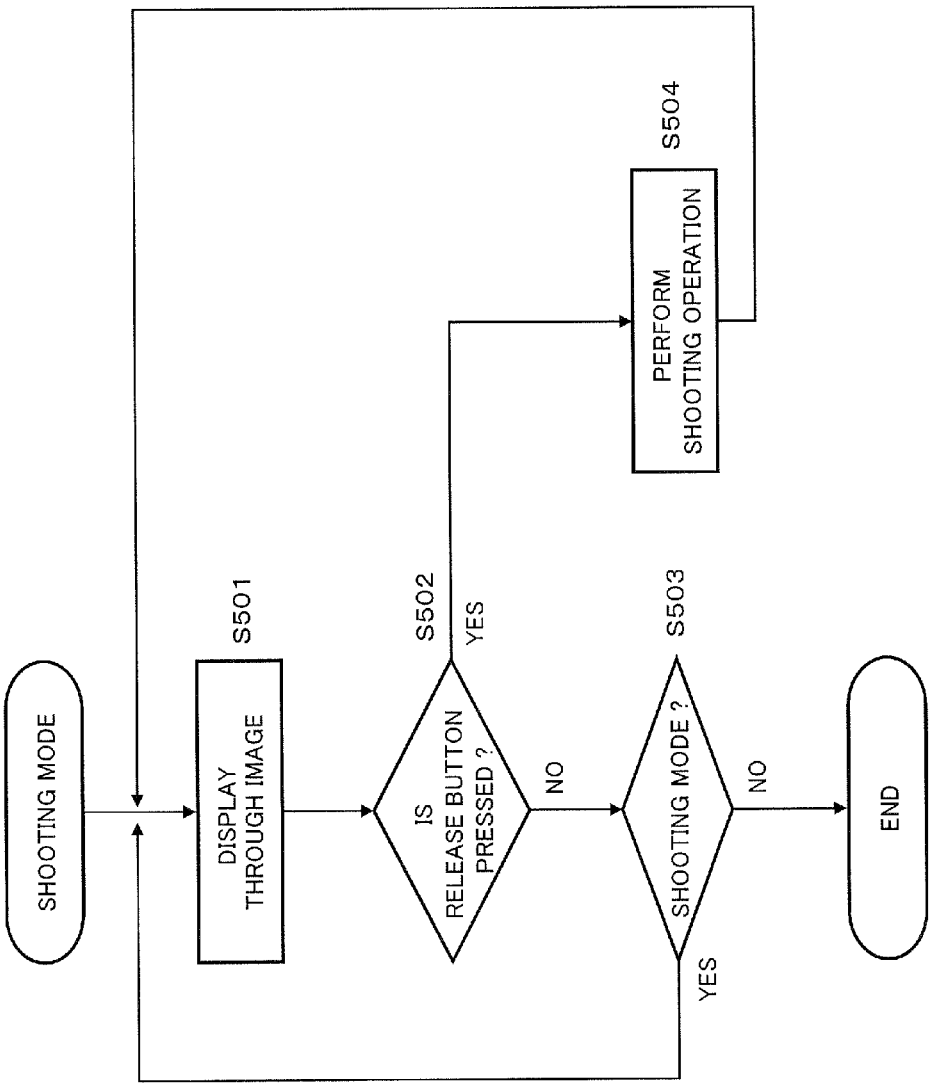

SHOOTING MODE
S501
DISPLAY THROUGH IMAGE
S502
IS RELEASE BUTTON PRESSED ?
YES
NO
S504
PERFORM SHOOTING OPERATION
S503
SHOOTING MODE ?
YES
NO
END

Fig.6

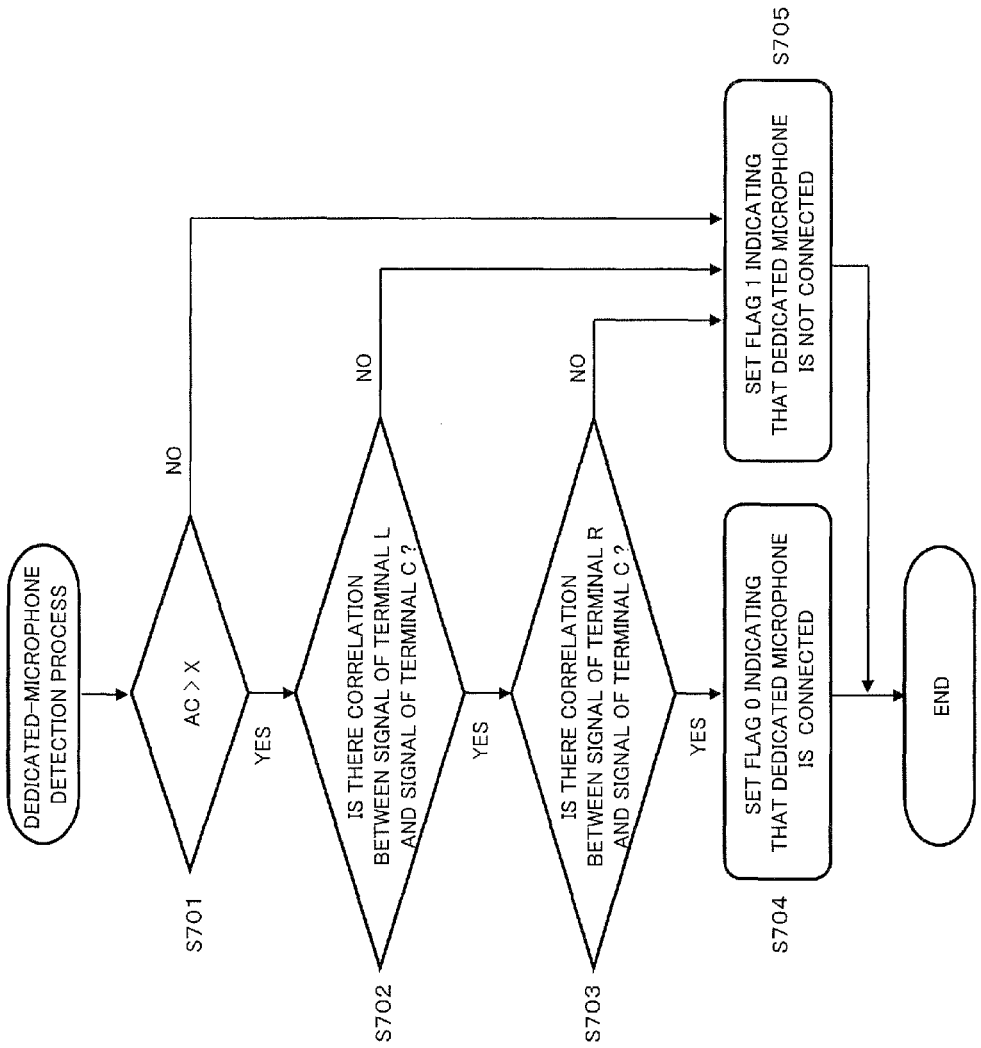
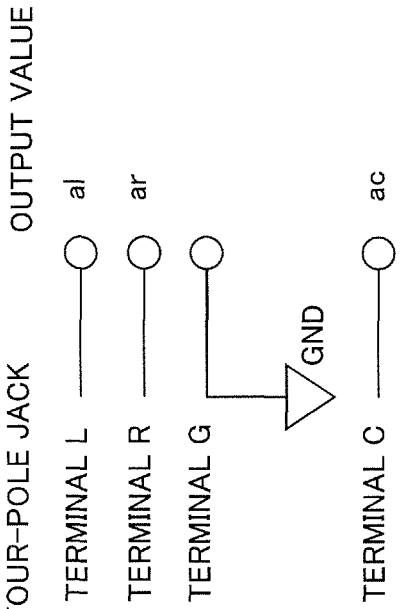

DEDICATED-MICROPHONE DETECTION PROCESS
AC > X
S701
NO
YES
IS THERE CORRELATION BETWEEN SIGNAL OF TERMINAL L AND SIGNAL OF TERMINAL C ?
S702
NO
YES
IS THERE CORRELATION BETWEEN SIGNAL OF TERMINAL R AND SIGNAL OF TERMINAL C ?
S703
NO
YES
SET FLAG 0 INDICATING THAT DEDICATED MICROPHONE IS CONNECTED
S704
SET FLAG 1 INDICATING THAT DEDICATED MICROPHONE IS NOT CONNECTED
S705
END

Fig. 7

Fig. 8


FOUR-POLE JACK
OUTPUT VALUE
TERMINAL L
al
TERMINAL R
ar
TERMINAL G
GND
TERMINAL C
ac

SOUND RECORDING DEVICE

BACKGROUND

1. Technical Field

The present disclosure relates to a sound recording device to which an external microphone can be connected.

2. Related Art

There is known a sound recording device capable of being connected with an external microphone (external sound pickup device) and capable of picking up sound with the external microphone. JP-A-2009-194890 discloses a configuration for automatically determining types of plural kinds of audio apparatuses in such a sound recording device.

This conventional sound recording device determines a type of the audio apparatus based on impedances of channels of the audio apparatus such as the external microphone connected to a jack interface of the sound recording device. With this configuration, using only one jack interface, the sound recording device can be adapted to plural kinds of audio apparatuses.

SUMMARY

Such a conventional sound recording device determines a type based on the impedances of the channels of the connected external sound pickup device. In this case, the determination may not be appropriate.

The present disclosure provides a sound recording device capable of more appropriately determining a type of a connected external sound pickup device.

The sound recording device of the present disclosure is a sound recording device to which an external sound pickup device can be connected. The sound recording device includes a connector having a plurality of terminals to which the external sound pickup device can be connected, and a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals of the plurality of terminals.

According to the present disclosure, a sound recording device capable of more appropriately determining a type of a connected external sound pickup device can be provided.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a front view of a digital camera according to a first embodiment.

FIG. **2** is a rear view of the digital camera according to the first embodiment.

FIG. **3** is a plan view of the digital camera according to the first embodiment.

FIG. **4** is a block diagram showing an electrical configuration of the digital camera according to the first embodiment.

FIG. **5** is a diagram showing a detailed example of a plug according to the first embodiment.

FIG. **6** is a flowchart showing a flow of an operation in a shooting mode of the digital camera according to the first embodiment.

FIG. **7** is a flowchart showing a flow of an operation of a dedicated-microphone detection process of the digital camera according to the first embodiment.

FIG. **8** is a diagram showing a relationship between a four-pole jack and output values of a sound input system of the digital camera according to the first embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereinafter, embodiments are described in detail with reference to the drawings as appropriate. However, a detailed description more than necessary may be omitted. For example, a detailed description of an already well-known matter and a duplicate description of a substantially identical configuration may be omitted. This is for the purpose of avoiding a subsequent unnecessary redundant description and facilitating the understanding of those skilled in the art.

The inventor(s) provide the appended drawings and the following description to enable those skilled in the art to fully understand the present disclosure, and do not intend to limit the subject described in claims by the drawings and the description.

First Embodiment

A digital camera of the first embodiment includes a jack for connecting an external microphone. When the external microphone is connected to the digital camera, the digital camera determines whether the connected external microphone is a dedicated microphone. A configuration and an operation of the digital camera are described below.

[1. Configuration]

A configuration of a digital camera **100** is described below with reference to the drawings.

[1-1. Configuration of the Digital Camera **100**]

FIG. **1** is a front view of the digital camera **100**. The digital camera **100** includes a lens tube **141** and a flash **200**, at the front. The digital camera **100** includes an operating unit **180** that has a release button **181**, a zoom lever **182**, a power button **183**, a mode dial **184**, and the like, and a shoe **201**, on an upper surface of the digital camera **100**. An external microphone **300** is mechanically and electrically connectable to the digital camera **100**. The shoe **201** can mechanically fix the external microphone **300**. The external microphone **300** includes a sound pickup unit **301**, a cable **302** connected to the sound pickup unit **301**, and a plug **303** to which the cable **302** is connected. The plug **303** is electrically connectable to a jack **203** provided on a side surface of the digital camera **100**. A sound signal picked up by the sound pickup unit **301** of the external microphone **300** is input to an analog audio processor, a digital audio/video processor (described later) and the like of the digital camera **100**, through the cable **302**, the plug **303**, and the jack **203**.

FIG. **2** is a rear view of the digital camera **100**. The digital camera **100** includes the operating unit **180** that has a center button **185**, a cross button **186**, and the like, and a display unit **190**, on a rear surface of the digital camera **100**.

FIG. **3** is a plan view of the digital camera **100**. A microphone aperture **210** is formed on an upper surface of the digital camera **100**. The digital camera **100** includes an internal microphone **111** at a lower part of the microphone aperture **210**.

FIG. **4** is an electrical configuration diagram of the digital camera **100**. The digital camera **100** includes an image input system **140**, a sound input system **110**, the digital audio/video processor **120**, a controller **130**, a RAM **150**, an external storage medium **160**, a ROM **170**, the operating unit **180**, the display unit **190**, and a speaker **195**.

The digital camera **100** generates image information and a sound signal from information obtained from outside. The image information is generated by the image input system **140**. The sound signal is generated by the sound input system **110**. The image information and the sound signal generated are A/D converted (analog/digital conversion), and are processed respectively by the digital audio/video processor **120**.

Thereafter, the image information and the sound signal are recorded in the external storage medium **160** such as a memory card. The image information recorded in the external storage medium **160** is displayed in the display unit **190** when a user has performed a predetermined operation to the operating unit **180**. The sound signal recorded in the external storage medium **160** is output from the speaker **195** upon reception of the operation of the operating unit **180** by the user.

FIG. **5** is a diagram showing a configuration example of a plug of the external microphone. The plug of the external microphone includes one that has terminals of four poles like a plug **303***a*, and the other that has terminals of three poles like a plug **303***b*. The dedicated microphone that can be connected to the digital camera **100** of the present embodiment is assumed to include the plug **303***a*. A general two-channel stereo microphone includes the plug **303***b*.

The parts shown in FIG. **1** through FIG. **5** are described in detail below.

The image input system **140** includes the lens tube **141**, a lens controller **142**, a CCD image sensor **143**, and an AFE (analog front end) **144**.

The lens tube **141** includes an optical system having plural lenses. The lens tube **141** causes a predetermined lens of the plural lenses to move by a motor driven according to a control signal notified from the lens controller **142**. With this configuration, a subject image is formed, by adjusting a focus of a subject, adjusting an image angle, adjusting a quantity of incident light, and adjusting a camera shake.

The CCD image sensor **143** generates the image information by capturing the subject image formed through the lens tube **141**. A large number of photodiodes are arranged two-dimensionally (in a matrix shape) on a light reception surface of the CCD image sensor **143**. A primary color filter of R, G, or B is disposed corresponding to each photodiode. The primary color filters of R, G, and B are disposed in a predetermined layout structure. Light from the subject that becomes an object to be captured passes through the lens tube **141**, and then forms an image on the light reception surface of the CCD image sensor **143**. The formed subject image is converted into R, G, or B color information. The color information is information that changes according to a light quantity incident to each photodiode. As a result of the conversion, image information that indicates an entire subject image is generated. Each photodiode corresponds to a pixel of the CCD image sensor **143**. However, the color information actually output from each photodiode is any one of primary color information of R, G, and B. Therefore, a color to be expressed by each pixel is generated based on primary color information (color, light quantity) that is output from a photodiode corresponding to each pixel and its peripheral photodiodes, in the digital audio/video processor **120** that is at a subsequent stage. The CCD image sensor **143** can generate image information of a new frame at each constant time when the digital camera **100** is in a shooting mode.

The AFE **144** performs noise suppression by a correlated double sampling to the image information that is read from the CCD image sensor **143**, amplification to an input range width of an A/D converter by an analog gain controller, and an A/D conversion by the A/D converter. Thereafter, the AFE **144** outputs the image information to the digital audio/video processor **120**.

The sound input system **110** includes the internal microphone **111**, the jack **203**, a detector **202**, and the analog audio processor **115**. The sound input system **110** can be connected with the external microphone **300**. The external microphone **300** includes the sound pickup unit **301**, the cable **302**, and the plug **303**. The sound pickup unit **301** includes a microphone **301**L that picks up sound from a left direction, a microphone **301**R that picks up sound from a right direction, and a microphone **301**C that picks up sound from a front direction. The microphone **301**L, the microphone **301**R, and the microphone **301**C are disposed at close positions and have the same sensitivities.

The plug **303** may have terminals of four poles like the plug **303***a*, for example. A terminal arrangement of the plug in this case is L (left channel), R (right channel), G (ground), and C (center channel) in order from a front end, for example. Further, the plug **303** may have terminals of three poles like the plug **303***b*, for example. A terminal arrangement of the plug in this case is L (left channel), R (right channel), and G (ground) in order from a front end, for example. Connection terminals of the jack **203** have four or more poles. In the present embodiment, the dedicated microphone corresponding to the digital camera **100** is assumed to include the plug **303***a*. The jack **203** is assumed to include the terminals L, R, G, and C corresponding to the plug **303***a* of the dedicated microphone.

The detector **202** of the digital camera **100** detects whether the plug **303** of the external microphone **300** is connected to the jack **203**. A detection method can be a mechanical method or an electrical method. The mechanical method is a method such that when the plug **303** is connected to the jack **203**, a front end of the plug **303** presses a switch and the detector **202** can detect a state of the press, for example. The electrical method is a method such that a predetermined wiring of which an electric resistance value changes depending on whether the plug **303** is connected to the jack **203** is prepared, and the detector **202** can detect the electric resistance value, for example.

When the detector **202** detects that the plug **303** is connected to the jack **203**, the analog audio processor **115** selects and processes the input of the external microphone **300** with priority over the input of the internal microphone **111**. On the other hand, when the detector **202** detects that the plug **303** is not connected to the jack **203**, the analog audio processor **115** processes the input of the internal microphone **111**. That is, during a period when the external microphone **300** is being connected to the digital camera **100**, the external microphone **300** picks up sound, and during a period when the external microphone **300** is not being connected to the digital camera **100**, the internal microphone **111** picks up sound. Therefore, the analog audio processor **115** can receive inputs of sound signals from the external microphone **300** and the internal microphone **111**. However, at the same timing, the analog audio processor **115** processes the sound signal from only one of the external microphone **300** and the internal microphone **111**.

The analog audio processor **115** A/D converts the processed sound signal by the A/D converter, and outputs the converted sound signal to the digital audio/video processor **120**.

The digital audio/video processor **120** performs various kinds of processes to image information that is output from the AFE **144** and to a sound signal that is output from the analog audio processor **115**. For example, the digital audio/video processor **120** performs a gamma correction and a white balance correction, a flaw correction, an encoding process, and the like, to the image information, according to instructions from the controller **130**. Further, the digital audio/video processor **120** performs various kinds of processes to the sound signal according to instructions from the controller **130**. The digital audio/video processor **120** may be realized by a hardwired electronic circuit or by a microcomputer that executes programs. The digital audio/video proces-

sor **120** may be realized as one semiconductor chip integrally with the controller **130** and the like.

The display unit **190** is disposed on the rear surface of the digital camera **100**. In the present embodiment, the display unit **190** is a liquid-crystal display unit. The display unit **190** displays an image based on the image information processed by the digital audio/video processor **120**. The image displayed by the display unit **190** includes a through image and a reproduction image.

The through image is an image of a frame that is continuously newly generated at each constant time by the CCD image sensor **143**. Usually, when the digital camera **100** is set in the shooting mode and also when the digital camera **100** is in a waiting state of not capturing a still image or in a moving-image capturing state, the digital audio/video processor **120** generates the through image from the image information generated by the CCD image sensor **143**. The user can shoot the subject by confirming a composition of the subject, by referring to the through image displayed in the display unit **190**.

The reproduction image is generated by the digital audio/video processor **120** when the digital camera **100** is in a reproduction mode. The reproduction image is an image obtained by reducing a recorded image of a high pixel recorded in the external storage medium **160** or the like to an image of a low pixel by matching the image to a size of the display unit **190**.

The image information of the high pixel that is recorded in the external storage medium **160** is generated by the digital audio/video processor **120** based on the image information generated by the COD image sensor **143**, after the release button **181** receives a predetermined operation by the user. The speaker **195** outputs a sound signal recorded in the external storage medium **160**.

The controller **130** performs an integrated control of an entire operation of the digital camera **100**.

The ROM **170** stores a program for the integrated control of the entire operation of the digital camera **100**, in addition to a program related to an autofocus control (AF control) and an automatic exposure control (AE control), and a light emission control of the flash **200**, these programs being performed by the controller **130**.

The ROM **170** stores various kinds of settings related to the digital camera **100**. In the present embodiment, the ROM **170** is a flash ROM.

The controller **130** may be realized by a hardwired electronic circuit or by a microcomputer that executes programs. The controller **130** may be realized as one semiconductor chip integrally with the digital audio/video processor **120** and the like. The ROM **170** does not need to exist (as a unit separate from the controller **130**) at the outside of the controller **130**, and may be built inside the controller **130**.

The RAM **150** functions as a work memory of the digital audio/video processor **120** and the controller **130**. The RAM **150** can be realized by an SDRAM and a flash memory. The RAM **150** also functions as an internal memory for recording the image information and the sound signal.

The external storage medium **160** is an external memory that internally includes a nonvolatile recording unit such as a flash memory. The external storage medium **160** can be recorded with data such as the image information and the sound signal that are processed by the digital audio/video processor **120**.

The operating unit **180** is a generic name of an operation interface such as an operation button and an operation dial that are disposed on an outer covering of the digital camera **100**. The operating unit **180** receives an operation by a user. For example, the operating unit **180** corresponds to the release button **181**, the zoom lever **182**, the power button **183**, the mode dial **184**, the center button **185**, and the cross button **186** that are shown in FIGS. **1**, **2**, and **3**. The operating unit **180** notifies a signal instructing various operations to the controller **130**, when receiving an operation by a user.

The release button **181** is a press button that shifts between two stages of a half-press state and a full-press state. When the release button **181** is half pressed by the user, the controller **130** performs both or either one of an AF (Auto Focus) control and an AE (Auto Exposure) control, and determines an imaging condition. In the AF control, the digital audio/video processor **120** calculates a contrast value in a predetermined region of the image information. Based on this, the controller **130** causes the lens tube **141** to be driven through the lens controller **142**, and performs a feedback control to make the contrast value become maximum. As a result of the AF control, the controller **130** can obtain a focal distance to the subject to be AF controlled. As a result of the AF control, the lens tube **141** can cause the CCD image sensor **143** to form an image of the subject to be AF controlled. Subsequently, when the release button **181** is fully pressed by the user, the controller **130** causes the image information captured at a full press timing to be recorded in the external storage medium **160** or the like.

The zoom lever **182** is a lever having a wide-angle end and a telephoto end for an image angle adjustment. The zoom lever **182** is a self-return type lever that automatically returns to a center position when the operation by the user is canceled. When operated by the user, the zoom lever **182** notifies a signal to the controller **130** to instruct the lens tube **141** to be driven. That is, when the user shifts the zoom lever **182** to a wide-angle side, the controller **130** drives the lens tube **141** to be able to capture the subject image at a wide angle through the lens controller **142**. Similarly, when the user shifts the zoom lever **182** to a telephoto side, the controller **130** drives the lens tube **141** through the lens controller **142** to be able to capture the subject image by telephoto.

The power button **183** is a slide button for turning ON/OFF a power supply to each unit of the digital camera **100**. When the power button **183** is slid rightward by the user when the power supply is OFF, the controller **130** causes power to be supplied to each unit of the digital camera **100**, and activates each unit. When the power button **183** is slid leftward by the user when the power supply is ON, the controller **130** stops the power supply to each unit of the digital camera **100**.

The mode dial **184** is a rotation dial. When the mode dial **184** is turned by the user, the controller **130** switches an operation mode of the digital camera **100** to an operation mode corresponding to a current rotation position of the mode dial **184**. The operation mode includes an auto shooting mode, a manual shooting mode, a scene selection mode, a reproduction mode, for example. The auto shooting mode, the manual shooting mode, and the scene selection mode are generically called the shooting mode.

The center button **185** is a press button. When the center button **185** is pressed by the user when the digital camera **100** is in the shooting mode or the reproduction mode, the controller **130** causes a menu screen to be displayed in the display unit **190**. The menu screen is a screen in which the user is required to set various imaging conditions and reproduction conditions. When the center button **185** is pressed in a state that values of setting items of various conditions are selected by the user on the menu screen, the setting items are determined in these values. The determined setting is stored in the ROM **170**.

The cross button **186** includes four press buttons provided in vertical and lateral directions. The user can select values of setting items of various conditions displayed on the menu screen, by pressing a button of one of the directions of the cross button **186**.

The flash **200** includes a xenon tube, a capacitor, a booster circuit, and a light-emission trigger circuit. The booster circuit applies a high voltage to the capacitor according to a control signal from the controller **130**. The light-emission trigger circuit causes a high voltage of a charged capacitor to be discharged according to a control signal from the controller **130**, and causes a momentary light emission of a xenon gas in the xenon tube to occur. The light-emission trigger circuit causes the high voltage of the capacitor to be discharged synchronously with the imaging. With this configuration, the digital camera **100** can capture the subject that is illuminated with light generated by the light emission. That is, when the flash **200** momentarily emits light to the subject at the imaging time, the subject supplemented with brightness can be captured. The light emission by the flash **200** includes a pre-light emission and a main-light emission. The pre-light emission is a light emission before the imaging, for obtaining a light emission quantity of the flash **200** at the imaging time according to a result of determining a distance from the camera to the subject based on a degree of a reflected light quantity from the subject by the flash light emission. The main-light emission is a light emission performed synchronously with a timing of imaging based on the light emission quantity obtained by the pre-light emission.

[1-2. Correspondence Relationships]

The external microphone **300** is an example of the external sound pickup device. The microphone **301**L, the microphone **301**R, and the microphone **301**C are examples of microphones that the sound pickup unit **301** of the external sound pickup device includes. The jack **203** is an example of the connector. The controller **130** is an example of the determiner. The digital camera **100** is an example of the sound recording device.

[2. Operation]

The operation of the digital camera **100** according to the first embodiment in the shooting mode will be described. The digital camera **100** displays the through image in the display unit **190**, in a waiting state in the shooting mode or in a moving-image capturing state during a capturing of a moving image. When the external microphone **300** is connected to the digital camera **100**, the digital camera **100** checks sound signals of the channels picked up by the external microphone **300**, and performs a dedicated-microphone detection process of detecting whether the external microphone **300** is the dedicated microphone. A flow of an entire operation in the shooting mode is described first, and next the dedicated-microphone detection process is described below with reference to FIGS. **6** and **7**.

[2-1. Operation in the Shooting Mode]

FIG. **6** is a flowchart showing the flow of the entire operation in the shooting mode of the digital camera **100**. When the power button **183** is pressed and the power is supplied, the digital camera **100** enters the shooting mode. When the mode dial **184** is pressed and the instruction to switch the reproduction mode to the shooting mode is output, the digital camera **100** also enters the shooting mode. In the shooting mode, a process shown in FIG. **6** is started. The controller **130** displays in the display unit **190** the through image that is output by the digital audio/video processor **120** (S**501**). Thereafter, when the detecting unit **202** detects a connection of the jack **203**, the controller **130** checks output values of the terminals of the jack **203**, and performs the dedicated-microphone detection process of detecting whether a device connected to the jack **203** is the dedicated microphone (S**502**). Next, the controller **130** determines whether the release button **181** is pressed (S**502**). When it is determined in step S**502** that the release button **181** is pressed, the imaging operation is performed (S**504**). When it is determined in step S**502** that the release button **181** is not pressed, the controller **130** determines whether the current operation mode is the shooting mode (S**503**). When it is determined in step S**503** that the operation mode is the shooting mode, the process returns to step S**501** as the start point of the operation in the shooting mode. When it is determined in step S**503** that the operation mode is not the shooting mode, the operation in the shooting mode ends.

[2-2. Dedicated-Microphone Detection Process]

FIG. **7** is a flowchart showing the dedicated-microphone detection process. The microphone **301**L, the microphone **301**R, and the microphone **301**C are disposed at mutually close positions and have the same sensitivities, as described above. Therefore, characteristics of signals picked up by the microphone **301**L, the microphone **301**R, and the microphone **301**C are similar to each other (that is, the signals have a mutual correlation). In the present embodiment, the dedicated-microphone detection process is performed using this characteristic. Specifically, a correlation between the sound signal from the microphone **301**L, the sound signal from the microphone **301**R, and the sound signal from the microphone **301**C is determined, and the dedicated-microphone detection process is performed based on a result of the determination. This is described in detail below.

When the detector **202** detects a connection in the jack **203**, the controller **130** performs the dedicated-microphone detection process according to the flowchart of FIG. **7**. Output values (voltages) of the terminals of the jack **203** are defined as follows. FIG. **8** is a diagram showing a relationship between the terminals of the four-pole jack of the sound input system **110** and output values of the terminals. It is assumed that an output value of the terminal L of the jack **203** is al, an output value of the terminal R of the jack **203** is ar, and an output value of the terminal C of the jack **203** is ac. The output values of the terminals are based on an output value of the terminal G of the jack **203**.

An average value of the output value ac of the terminal C of the jack **203** in a period T is expressed as AC. The average value AC is defined by Formula 1, for example.

$$AC = \frac{1}{T}\int_{t_1}^{t_1+T} ac(t)dt \qquad \text{[Formula 1]}$$

The controller **130** checks whether the average value AC is larger than a predetermined threshold value X (whether "AC>X") (S**701**).

When "AC>X" is true in step S**701**, the controller **130** checks presence of a correlation between the output value al of the terminal L and the output value ac of the terminal C (S**702**). To determine presence of a correlation, authenticity of "$\alpha f(ac)<f(al)<\beta f(ac)$" is checked, for example. The coefficient α and the coefficient β are predetermined coefficients, and the function f is a predetermined function. The coefficient α is 0.8, for example, and the coefficient β is 1.2, for example. The function f is defined by Formula 2, for example.

$$f(x(t)) = \frac{1}{T_1}\int_{t_1}^{t_1+T_1}\left|x(t) - \frac{1}{T_2}\int_{t_2}^{t_2+T_2} x(t)dt\right|dt \quad \text{[Formula 2]}$$

When there is a correlation between the output value al and the output value ac, for example, when "αf(ac)<f(al)<βf(ac)" is true in step **S702**, the controller **130** checks presence of a correlation between the output value ar and the output value ac (**S703**). The controller **130** checks authenticity of "αf(ac)<f(ar)<βf(ac)", for example. The coefficient α and the coefficient β are predetermined coefficients. The function f is a predetermined function. The function f is defined by Formula 2, for example.

When there is a correlation between the output value ar of the terminal R and the output value ac of the terminal C, for example, when "αf(ac)<f(ar)<βf(ac)" is true in step **S703**, the controller **130** sets a flag **0** indicating that the dedicated microphone is connected (**S704**).

On the other hand, when "AC>X" is false in step **S701**, or when there is no correlation between the output value al and the output value ac (for example, when "αf(ac)<f(al)<βf(ac)" is false) in step **S702**, or when there is no correlation between the output value ar and the output value ac (for example, when "αf(ac)<f(ar)<βf(ac)" is false) in step **S703**, the controller **130** sets a flag **1** indicating that the dedicated microphone is not connected (**S705**).

After one of the flag setting process in step **S704** and the flag setting process in step **S705** ends, the dedicated-microphone detection process ends.

In the manner as described above, presence of a connection of the dedicated microphone to the digital camera **100** is detected, and the flag is set based on a result of the detection. When a setting menu is activated by the user after the flag is set by the above described dedicated-microphone detection process, the controller **130** performs a setting of selectable/unselectable of an extension function in the setting menu by referring to the set flag. The extension function is a variable function of a directional characteristic of the dedicated microphone, or a switch function of a switch between a stereo microphone recording (L/R) and a center microphone recording (C), for example. When the flag **0** indicating that the dedicated microphone is connected is being set, the controller **130** sets an item of the extension function prepared for the dedicated microphone to selectable, in the setting menu. For example, in displaying the item of the extension function to be set in the display unit **190** by operating the operating unit **180**, the controller **130** switches the item of the extension function prepared for the dedicated microphone from a grayout display to an ordinary display, and at the same time, sets the item to selectable. On the other hand, when the flag **1** indicating that the dedicated microphone is not connected is being set, the controller **130** sets the extension function prepared for the dedicated microphone to unselectable. For example, in displaying the item of the extension function to be set in the display unit **190** by operating the operating unit **180**, the controller **130** switches the item of the extension function prepared for the dedicated microphone to the grayout display, and at the same time, sets the item to unselectable.

Upon detecting that the plug **303** of the external microphone **300** is extracted from the jack **203**, the controller **130** sets the flag **1** indicating that the dedicated microphone is not connected. Then, the controller **130** sets the extension function prepared for the dedicated microphone to unselectable.

[3. Summary]

As described above, the controller **130** of the digital camera **100** in the present embodiment detects a connection of the dedicated microphone, based on a correlation between the output signals of the terminals of the dedicated microphone. When the controller **130** detects that an apparatus connected to the jack **203** is not the dedicated microphone, the controller **130** sets the flag **1** indicating that the dedicated microphone is not connected.

When the setting menu is activated by the user, the controller **130** sets the extension function prepared for the dedicated microphone to unselectable. For example, in displaying the item of the extension function to be set by operating the operating unit **180** in the display unit **190**, the controller **130** switches the item of the extension function prepared for the dedicated microphone to the grayout display, and at the same time, sets the item to unselectable. When the controller **130** detects that an apparatus connected to the jack **203** is the dedicated microphone, the controller **130** sets the flag **0** indicating that the dedicated microphone is connected. When the setting menu is activated by the user, the controller **130** sets the extension function prepared for the dedicated microphone to selectable. For example, in displaying the item of the extension function to be set by operating the operating unit **180** in the display unit **190**, the controller **130** switches the item of the extension function prepared for the dedicated microphone from the grayout display to the ordinary display, and at the same time, sets the item to selectable. With this configuration, when the apparatus connected to the jack **203** is not the dedicated microphone, the user can avoid an erroneous selection of the extension function for the dedicated microphone.

[4. Effects and the Like]

As described above, the digital camera **100** in the present embodiment is the digital camera **100** to which the external microphone **300** can be connected. The digital camera **100** includes the jack **203** having plural terminals to which the external microphone can be connected, and the controller **130** that determines a type of the external microphone when the external microphone is connected to the jack **203**, based on a correlation between the signals of specific terminals out of the plurality of terminals.

With this configuration, when the external microphone is connected to the jack **203**, a type of the connected external microphone can be determined based on a correlation between the signals of specific terminals out of the plural terminals. Therefore, the digital camera **100** capable of more appropriately determining a type of the connected external microphone can be provided.

Further, in the present embodiment, the plurality of terminals include the terminal C, the terminal L, and the terminal R. The controller **130** determines that the connected external microphone is the specific external microphone **300**, when a value concerning a correlation between a voltage of the terminal C and a voltage of the terminal L is higher than a first threshold value and also when a value concerning a correlation between a voltage of the terminal C and a voltage of the terminal R is higher than a second threshold value.

With this configuration, it can be easily determined that the connected external microphone is the specific external microphone **300**, based on the value concerning the correlation between the voltage of the terminal C and the voltage of the terminal L, and the value concerning the correlation between the voltage of the terminal C and the voltage of the terminal R.

The terminal C is a terminal to which the microphone C that picks up sound from the front direction is connected. The terminal L is a terminal to which the microphone L that picks up sound from the left direction is connected. The terminal R is a terminal to which the microphone R that picks up sound from the right direction is connected.

With this configuration, it can be easily determined that the connected external microphone is the specific external microphone **300**, based on a value concerning a correlation between the sound from the front direction and the sound from the left direction, and a value concerning a correlation between the sound from the front direction and the sound from the right direction.

The external microphone **300** includes the microphone C, the microphone L, and the microphone R.

With this configuration, a fact that the external microphone **300** including the microphone C, the microphone L, and the microphone R is connected can be easily determined, based on a value concerning a correlation between the sound from the front direction and the sound from the left direction, and a value concerning a correlation between the sound from the front direction and the sound from the right direction.

[Other Embodiments]

The first embodiment is described above as an exemplification of the technique disclosed in the present application. However, the technique in the present disclosure is not limited to the above exemplification, and can be also applied to an embodiment in which the first embodiment is suitably changed, replaced, added, and omitted. A new embodiment can be also provided by combining structural elements described in the first embodiment.

Other embodiments will be illustrated below.

(1) In the above embodiment, the plug **303***a* is shown as an example of the plug **303** that is included in the dedicated microphone. A terminal arrangement of the four poles of the plug **303***a* is described as L (left channel), R (right channel), G (ground), and C (center channel) in order from the front end. However, the terminal arrangement is not limited to this order. For example, the terminal arrangement of the four poles may be L (left channel), R (right channel), C (center channel), and G (ground) in order from the front end. Although the plug **303***a* is shown as an example of the plug **303** and the number of terminals of the plug is described as four poles, the number of terminals is not limited to this number.

(2) In the above embodiment, although the function f for checking a correlation in step S**702** and step S**703** is defined by Formula 2, the function f is not limited to be defined by this formula. For example, the function f may be defined by Formula 3. In short, an arbitrary function can be used when a correlation between the signals can be determined using this function.

$$f(x(t)) = \left\{ \frac{1}{N_1} \sum_{n=t_1}^{N_1-t_1} x(t+pn) \right\} - \left\{ \frac{1}{N_2} \sum_{n=t_2}^{N_2-t_2} x(t+qn) \right\} \quad \text{[Formula 3]}$$

(3) In the above embodiment, the digital camera **100** has a configuration in which the lens tube **141** is fixed. However, the lens tube **141** can be arranged to be exchangeable to the digital camera **100**.

(4) In the above embodiment, although the external microphone **300** is mechanically fixed to the shoe **201**, the external microphone **300** is not limited to this configuration. For example, at the time of a sound pickup by the external microphone **300**, the external microphone **300** does not need to be in a state of being fixed to the shoe **201**, that is, the digital camera **100**. It is sufficient that the external microphone **300** is electrically connected to the digital camera **100** and that the sound signal picked up by the external microphone **300** can be input to the digital camera **100**.

(5) In the above embodiment, although the sound signal that is input from the external microphone **300** is directly input to the analog audio processor **115**, the input of the sound signal is not limited to this direct input. For example, the sound signal that is input from the external microphone **300** may be input to the analog audio processor **115** through a low-pass filter (LPF).

(6) In the above embodiment, although the coefficient α and the coefficient β are constant values in the determination of a correlation, the coefficients may be changed according to conditions. For example, when a level of the sound signal is low, the coefficient α and the coefficient β may be set such that ranges expressed by $\alpha f(ac) < f(al) < \beta f(ac)$ and $\alpha f(ac) < f(ar) < \beta f(ac)$ become wider. When a level of the sound signal is low, the coefficient α may be set smaller, and the coefficient β may be set larger.

(7) In the above embodiment, when the detector **202** detects a connection of the jack **203**, the controller **130** performs the dedicated-microphone detection process shown in FIG. **7**. However, a timing of the performance of this process is not limited to this. For example, when the setting menu is activated by the user, the controller **130** may perform the dedicated-microphone detection process shown in FIG. **7**.

(8) In the above embodiment, the sound pickup unit **301** that the external microphone **300** includes has the microphone **301**L, the microphone **301**R, and the microphone **301**C. That is, the number of microphones that the external microphone **300** includes is three. However, the number is not limited to three. For example, the number of microphones that the external microphone **300** includes may be equal to or more than four. In this case, processes corresponding to those in steps S**702** and S**703** in the dedicated-microphone detection process shown in FIG. **7** may be added by the increased number of microphones.

(9) In the above embodiment, the sound signal picked up by the external microphone **300** is input to the digital camera **100** through the plug **303** and the jack **203** that are electrically connected. However, this configuration may be changed as follows.

That is, the shoe **201** includes a terminal for electrical connection. The external microphone **300** is electrically connected to this terminal as well as being mechanically connected to the shoe **201**. The external microphone **300** inputs the sound signal to the digital camera **100** through this terminal. The detector **202** detects that the external microphone **300** is mechanically fixed (connected) to the shoe **201** or is electrically connected to this terminal.

(10) In the above embodiment, the external microphone **300** is connected to the digital camera **100** by a wire. However, the external microphone **300** does not need to input the sound signal to the digital camera **100** through wired connection, and may input the sound signal through wireless connection. In this case, the external microphone **300** includes a microphone-side communicator, for example. Further, the sound input system **110** includes a camera-side communicator (an example of a connector). When a wireless connection is established between the microphone-side communicator and the camera-side communicator, the digital camera **100** starts receiving of the sound signal picked up by the external microphone **300**. When the wireless connection is established, the detector **202** detects that the external microphone **300** is connected to the digital camera **100**. The subsequent process is similar to that in the above embodiment.

(11) In the above embodiment, it is described that the digital audio/video processor **120** and the controller **130** have the functions and the configurations as described above. However, a part of the functions and the configurations that

one of the digital audio/video processor **120** and the controller **130** has may be included in the other.

(12) In the above embodiment, the CCD image sensor **143** is described as an example of the imaging device. However, the imaging device is not limited to this. That is, other imaging device such as a CMOS image sensor and an NMOS image sensor can be also applied to the present technique.

(13) In the above embodiment, an example of the application of the present technique to the digital camera **100** is described. However, the present technique can be also applied to other devices that cannot handle image information so far as the sound signal can be handled. For example, the present technique can be also similarly applied to a sound recording device such as a voice recorder to which the external microphone can be connected. The present technique can be also similarly applied to a sound recording device that does not include the internal microphone.

(14) In the above embodiment, although the display unit **190** is described as a liquid-crystal display unit, the display unit **190** is not limited to the liquid-crystal display unit in the present disclosure. The display unit **190** may be an LED lamp, for example. Then, an input state of the sound signal may be indicated by a number of lighting and a color of the LED lamp.

(15) In the above embodiment, the controller **130** determines whether the connected external microphone is the specific external microphone **300**, based on a correlation between the signals of specific terminals of the terminals L, R, and C. However, the content of the determination is not limited to this. For example, the controller may determine a type of the connected external microphone, based on a correlation between the signals of specific terminals of the terminals L, R, and C. Further, the controller may determine whether the connected dedicated microphone is normally functioning, based on a correlation between the signals of specific terminals of the terminals L, R, and C.

As described above, the present embodiment is described as the exemplification of the technique in the present disclosure. For this purpose, the appended drawings and the detailed description are provided.

Therefore, the constituent elements described in the appended drawings and the detailed description include not only the constituent elements that are essential to solve the problems but also the constituent elements that are not essential to solve the problems, to exemplify the above technique. Accordingly, based on the description of the not essential constituent elements in the appended drawings and the detailed description, the not essential constituent elements should never be immediately granted as essential.

Because the above embodiment is for exemplifying the technique in the present disclosure, various modifications, replacements, additions, and omissions can be performed within the range of claims or within the equivalent range of claims. Further, a new embodiment can be also provided by combining various constituent elements described in the first embodiment.

Industrial Applicability

According to the present disclosure, the sound recording device capable of more appropriately determining a type of the connected external sound pickup device can be provided. Therefore, the present disclosure can be applied to not only digital cameras but also other various kinds of sound recording devices that record sound data using an external microphone, such as movie cameras, portable telephones, and voice recorders.

What is claimed is:

1. A sound recording device to which an external sound pickup device can be connected, the sound recording device comprising:

a connector having a plurality of terminals to which the external sound pickup device can be connected; and

a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals of the plurality of terminals, the signals being signals changing temporally while the external sound pickup device is connected to the connector,

the plurality of terminals include a first terminal and a second terminal,

wherein the determiner is configured to determine the correlation between the signals by comparing a first value concerning an output signal of the first terminal and a second value concerning an output signal of the second terminal, wherein the first and second values are obtained by Formula 2, the parameter x is the voltage at the respective one of the first and second terminals, the parameter t represents time, the parameter T_1 represents a first duration, and the parameter T_2 represents a second duration.

$$f(x(t)) = \frac{1}{T_1}\int_{t_1}^{t_1+T_1}\left|x(t) - \frac{1}{T_2}\int_{t_2}^{t_2+T_2} x(t)\,dt\right|dt. \quad \text{[Formula 2]}$$

2. A sound recording device to which an external sound pickup device can be connected, the sound recording device comprising:

a connector having a plurality of terminals to which the external sound pickup device can be connected; and

a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals of the plurality of terminals, the signals being signals changing temporally while the external sound pickup device is connected to the connector,

the plurality of terminals include a first terminal and a second terminal,

wherein the determiner is configured to determine the correlation between the signals by comparing a first value concerning an output signal of the first terminal and a second value concerning an output signal of the second terminal, wherein the first and second values are obtained by Formula 3, the parameter x is the voltage at the respective one of the first and second terminals, the parameter t represents time, the parameter N_1 represents a first duration, the parameter N_2 represents a second duration, the parameter p represents a first constant value and the parameter q represents a second constant value.

$$f(x(t)) = \left\{\frac{1}{N_1}\sum_{n=t_1}^{N_1-t_1} x(t+pn)\right\} - \left\{\frac{1}{N_2}\sum_{n=t_2}^{N_2-t_2} x(t+qn)\right\}. \quad \text{[Formula 3]}$$

3. A sound recording device to which an external sound pickup device can be connected, the sound recording device comprising:

a connector having a plurality of terminals to which the external sound pickup device can be connected; and

a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals the plurality of terminals, the signals being signals changing temporally while the external sound pickup device is connected to the connector

wherein

the plurality of terminals include a first terminal L, a second terminal R, and a third terminal C,

the determiner determines a first time varying voltage value [f(al)] associated with the first terminal L. a second time varying voltage value [f(ar)] associated with the second terminal R, and a third time varying voltage value [f(ac)] associated with the third terminal C, and determines that the connected external sound pickup device is a specific external sound pickup device when both the first and second time varying voltage values [f(al)], [f(ar)] are greater than a first predetermined ratio of the third time varying voltage value α*[f(ac)] and less than a second predetermined ratio of the third time varying voltage value β*[f(ac)], α and β being predetermined coefficients.

4. The sound recording device according to claim **3**, wherein the determiner is configured to determine each of the first, second and third time varying voltage values by Formula 2, the parameter x is the voltage at the respective one of the first and second terminals, the parameter t represents time, the parameter T_1 represents a first duration, and the parameter T_2 represents a second duration.

$$f(x(t)) = \frac{1}{T_1}\int_{t_1}^{t_1+T_1}\left|x(t) - \frac{1}{T_2}\int_{t_2}^{t_2+T_2} x(t)\,dt\right|dt. \quad \text{[Formula 2]}$$

5. The sound recording device according to claim **3**, wherein the determiner is configured to determine each of the first, second and third time varying voltage values by Formula 3, the parameter x is the voltage at the respective one of the first and second terminals, the parameter t represents time, the parameter N_1 represents a first duration, the parameter N_2 represents a second duration, the parameter p represents a first constant value and the parameter q represents a second constant value.

$$f(x(t)) = \left\{\frac{1}{N_1}\sum_{n=t_1}^{N_1-t_1} x(t+pn)\right\} - \left\{\frac{1}{N_2}\sum_{n=t_2}^{N_2-t_2} x(t+qn)\right\}. \quad \text{[Formula 3]}$$

6. A sound recording device to which an external sound pickup device can be connected, the sound recording device comprising:

a connector having a plurality of terminals to which the external sound pickup device can be connected; and

a determiner that determines a type of the external sound pickup device when the external sound pickup device is connected to the connector, based on a correlation between signals of specific terminals of the plurality of terminals,

the plurality of terminals include a first terminal, a second terminal, and a third terminal, and

the determiner determines if a first value concerning an output signal of the first terminal and a second value concerning an output signal of the second terminal are higher than a first threshold value concerning an output signal of the third terminal and if the first value and the second value are less than a second threshold value concerning an output signal of the third terminal and determines that the connected external sound pickup device is a specific external sound pickup device when both the first and second values are higher than the first threshold value and less than the second threshold value.

7. The sound recording device according to claim **6**, wherein

the first terminal is a terminal to which a first external sound pickup device t picks up sound from a front direction is connected,

the second terminal is a terminal to which a second external sound pickup device that picks up sound from a left direction is connected, and

the third terminal is a terminal to which a third external sound pickup device that picks up sound from a right direction is connected.

8. The sound recording device according to claim **7**, wherein

the specific external sound pickup device includes the first external sound pickup device, the second external sound pickup device, and the third external sound pickup device.

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